OPTEK HALL EFFECT SENSOR OMH3075

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Outline

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- **Requirements**
- **Test Configuration**
- **Test Techniques**
- **Test Results**
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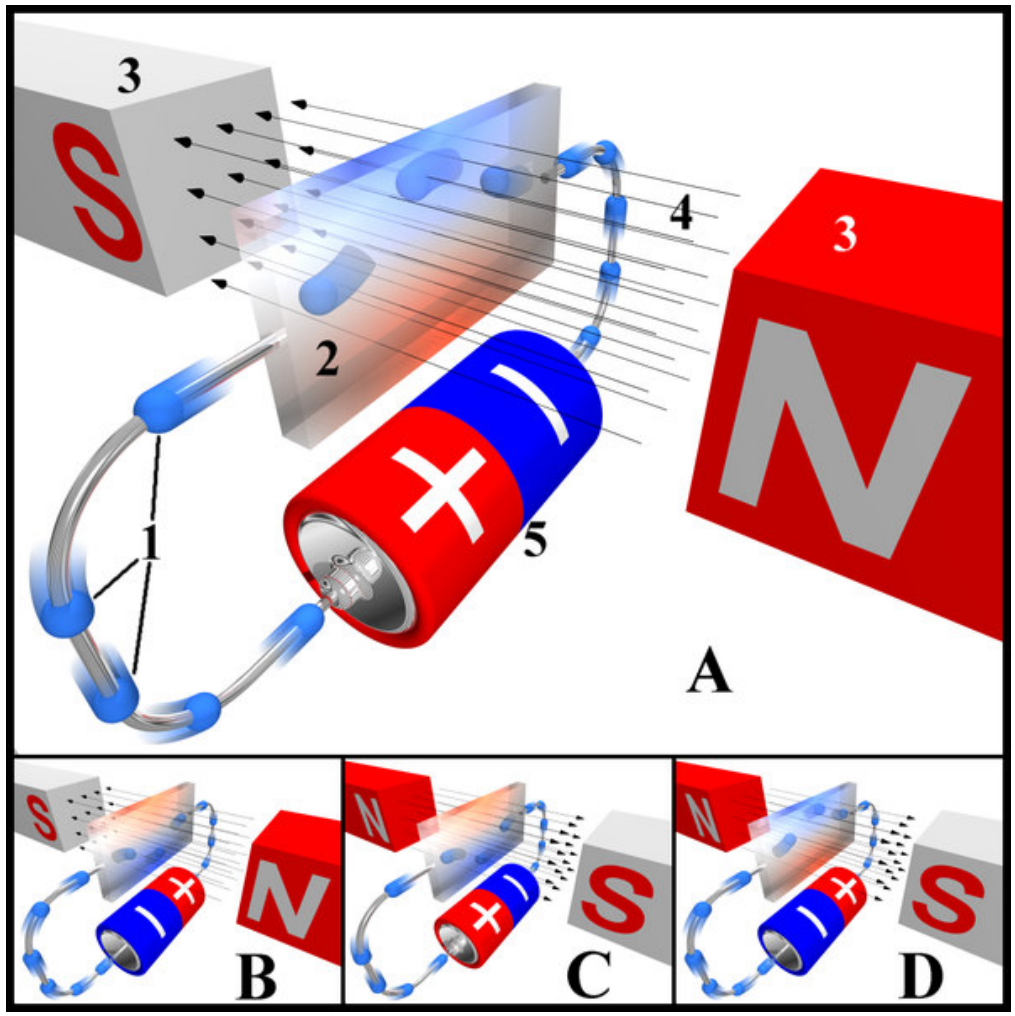
Hall Effect

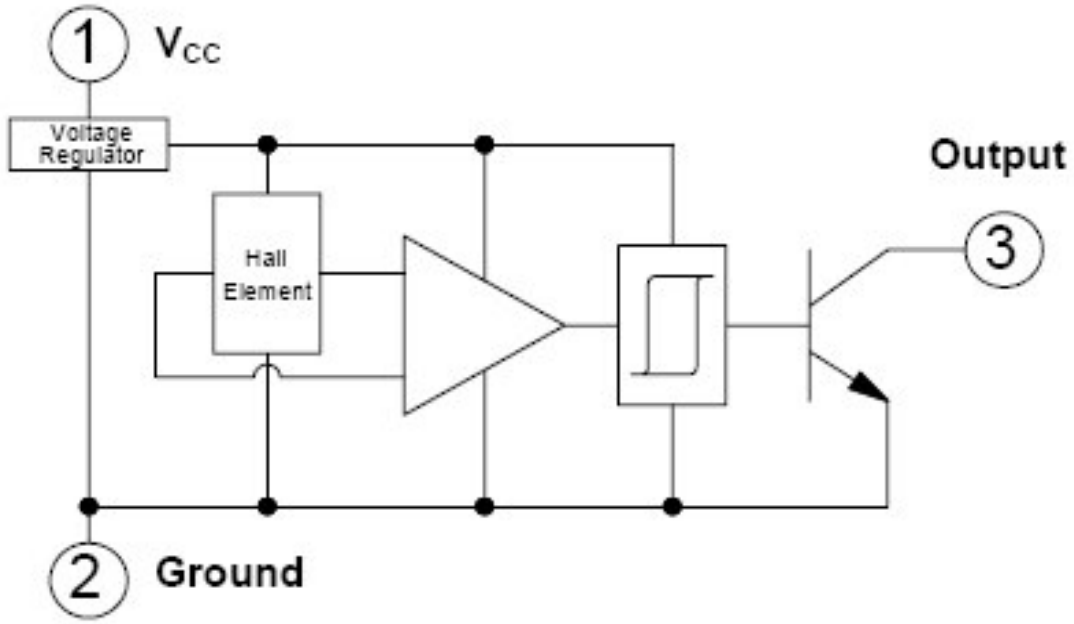


Hall Effect Diagram

- 1. Electrons
- 2. Hall element, or Hall sensor
- 3. Magnets
- 4. Magnetic field
- 5. Power source
- In "A", the Hall element takes on a negative charge at the top edge and positive at the lower edge.
- In "B" and "C", either the electric current or the magnetic field is reversed, causing the polarization to reverse.
- In “D", reversing both current and magnetic field causes the Hall element to again assume a negative charge at the upper edge.

Optek Hall Effect Sensor

- **Contains a monolithic integrated circuit which incorporates a Hall element, a linear amplifier, a threshold amplifier, and Schmitt trigger on a single Hallogic® silicon chip.**
- **Included on-chip is a band gap voltage regulator to allow operation with a range of 4.5 to 24 volt supply voltages.**
- **Output amplitude is constant at switching frequencies from DC to over 200 kHz.**
- **The Bi-Polar device turns on (logic level "0") in the presence of a magnetic south pole and turns off (logic level "1") when subjected to a magnetic north pole.**

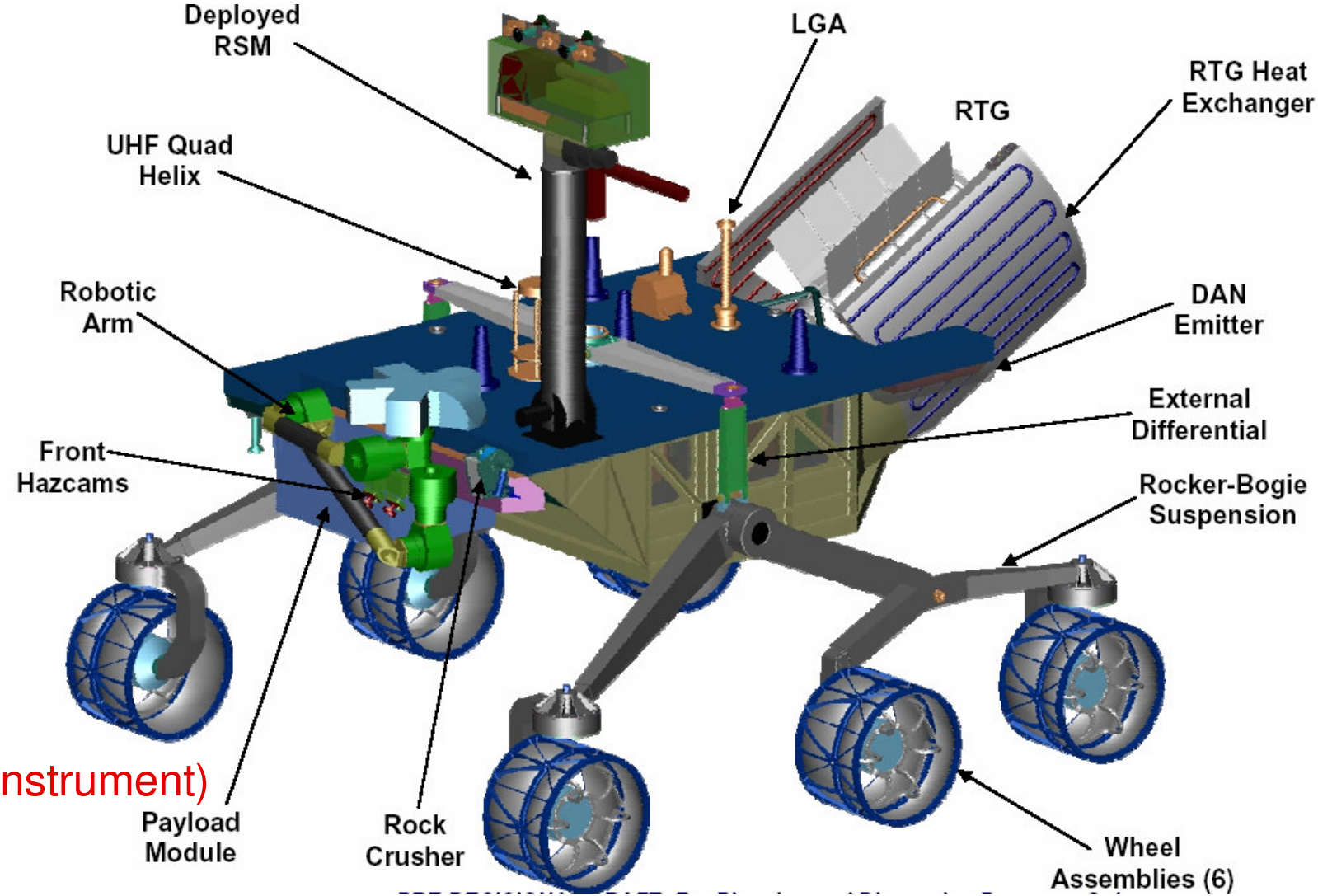


Internal Optek Hall Effect Sensor

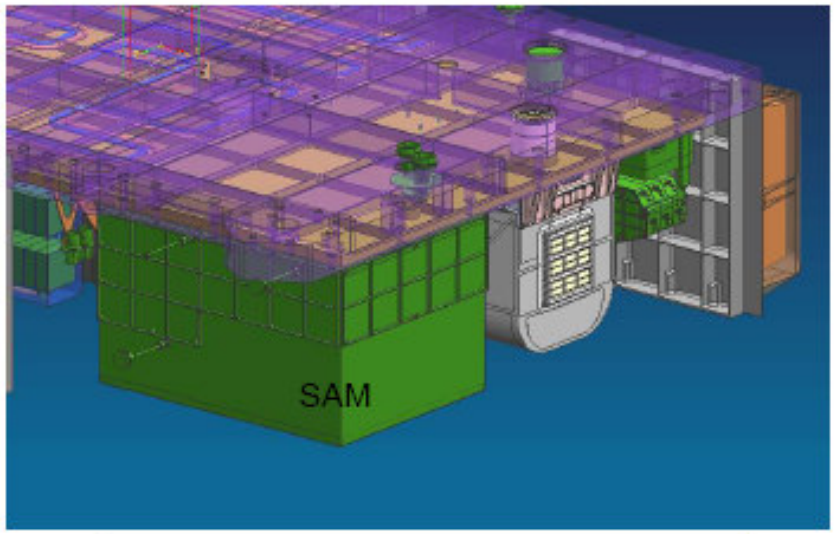
The Mission

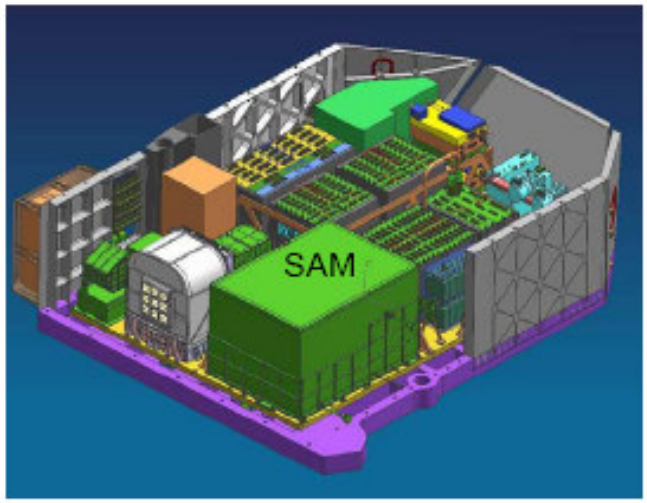
- The Mars Science Laboratory (MSL) project plans to launch a rover to a single location on Mars in the October - November 2009 launch opportunity as a part of the NASA OSS Mars Exploration Program (MEP).
  - MSL will conduct a Mars habitability investigation, with habitability defined as the "capacity of the environment to sustain life", i.e., the potential of a given environment to support life at some time, past or present.
- The MSL Rover will be launched from the NASA Kennedy Space Center Eastern Test Range, on an intermediate-class (e.g., Delta IV or Atlas V) launch vehicle
  - The cruise phase lasts approximately 10 to 14 months and begins when the spacecraft separates from the launch vehicle and ends prior to Mars entry, descent, and landing (EDL). The Rover will remain enclosed inside an aeroshell during the entire cruise.
  - The landing date ranges from May 2010 to not later than December 2010.
- The EDL phase begins when the vehicle reaches Mars altitude of approximately 125 km, and ends with a soft touchdown of the Rover on the Martian surface followed by the flyaway of the "sky-crane" descent stage.
- After landing, the primary landed mission operations will commence and last for approximately one Martian year, 670 sols (687 Earth days).

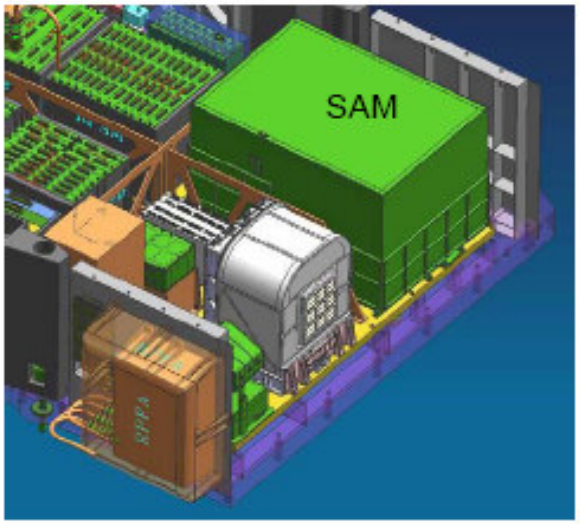
MSL Rover Configuration



SAM Instrument

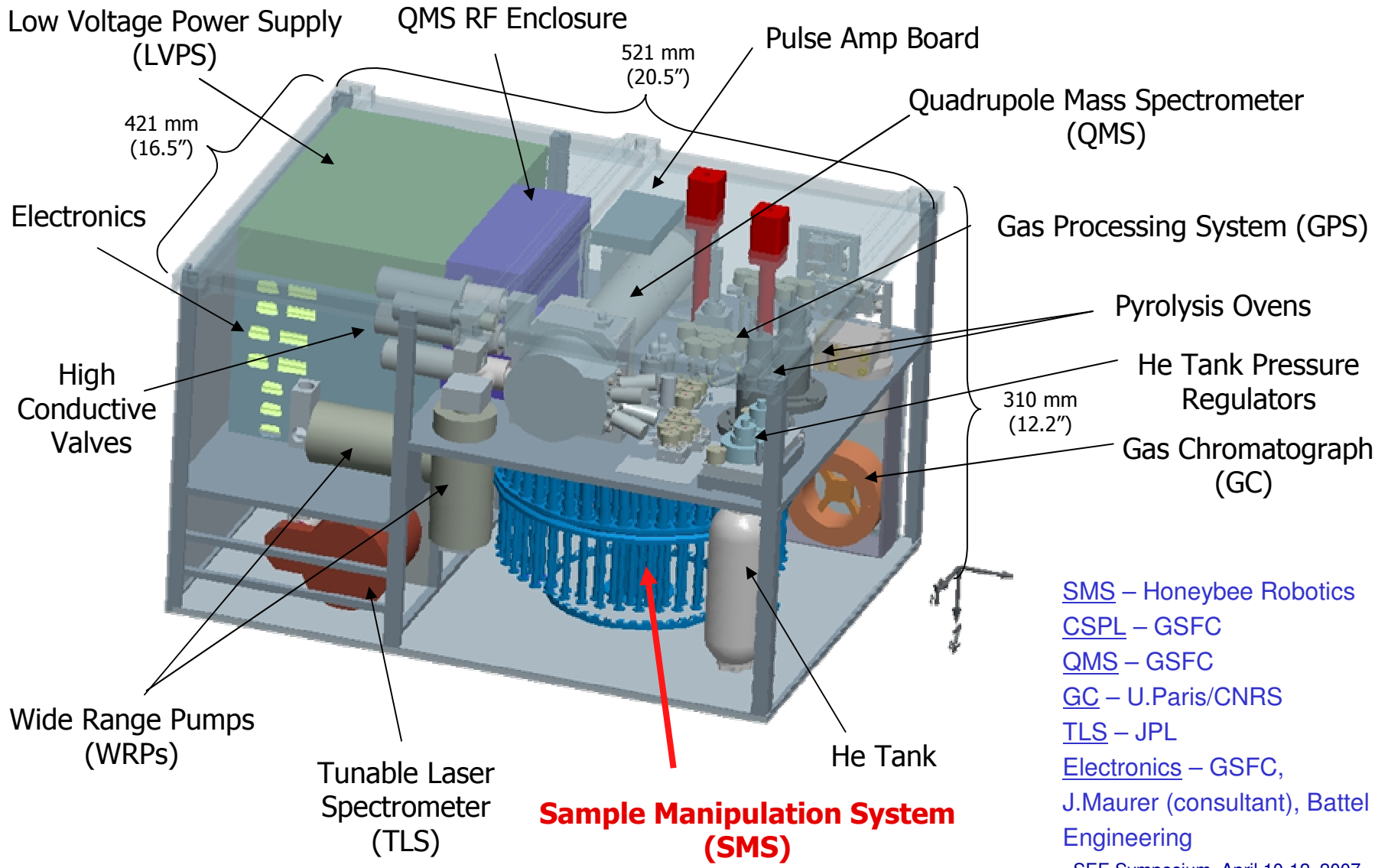






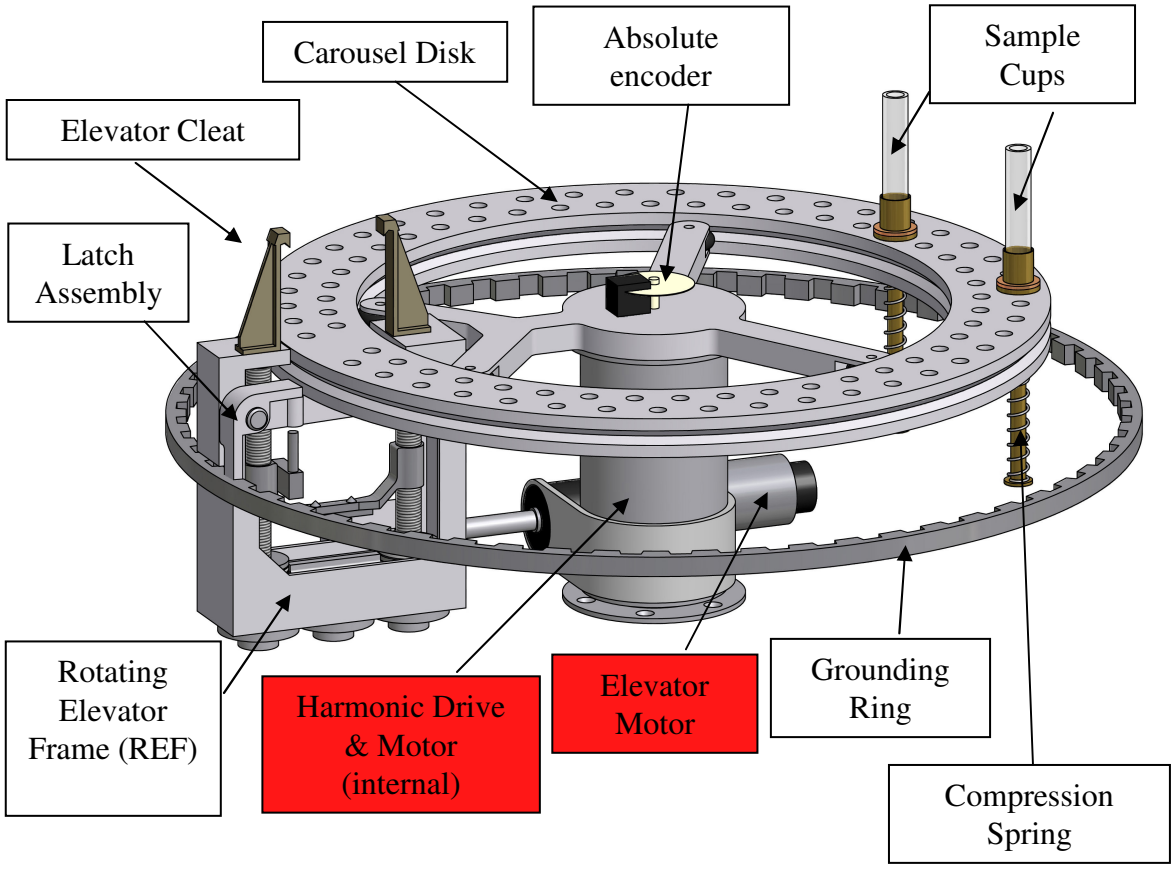
SAM Pre-CDR Detector Electronics Peer Review – November 17, 2006

Key Subsystems



SMS – Honeybee Robotics
CSPL – GSFC
QMS – GSFC
GC – U.Paris/CNRS
TLS – JPL
Electronics – GSFC, J.Maurer (consultant), Battel Engineering

Sample Manipulation System (SMS)



The SMS:

-Holds 88 sample cups

-Moves cups to the sample inlet

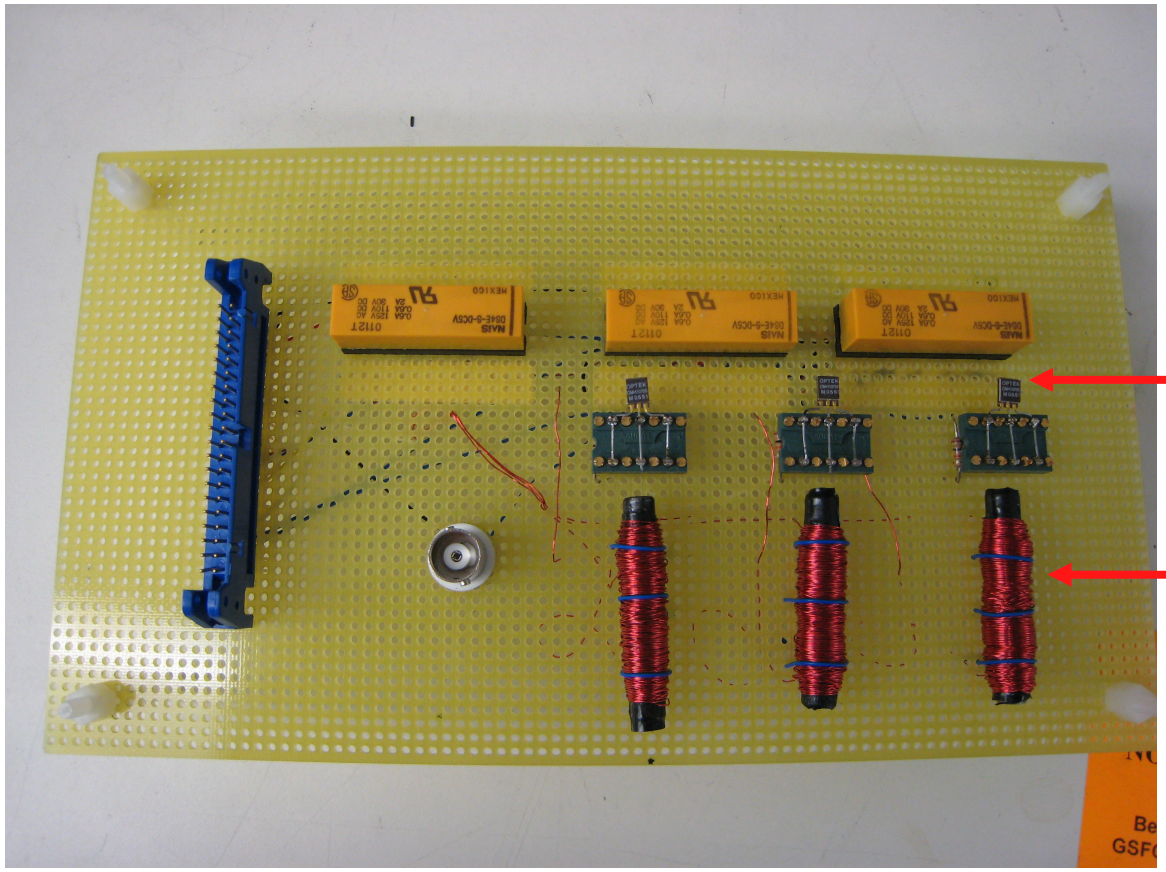
-Moves filled sample cups to the CSPL pyrolysis oven

Honeybee Robotics

Test Requirements

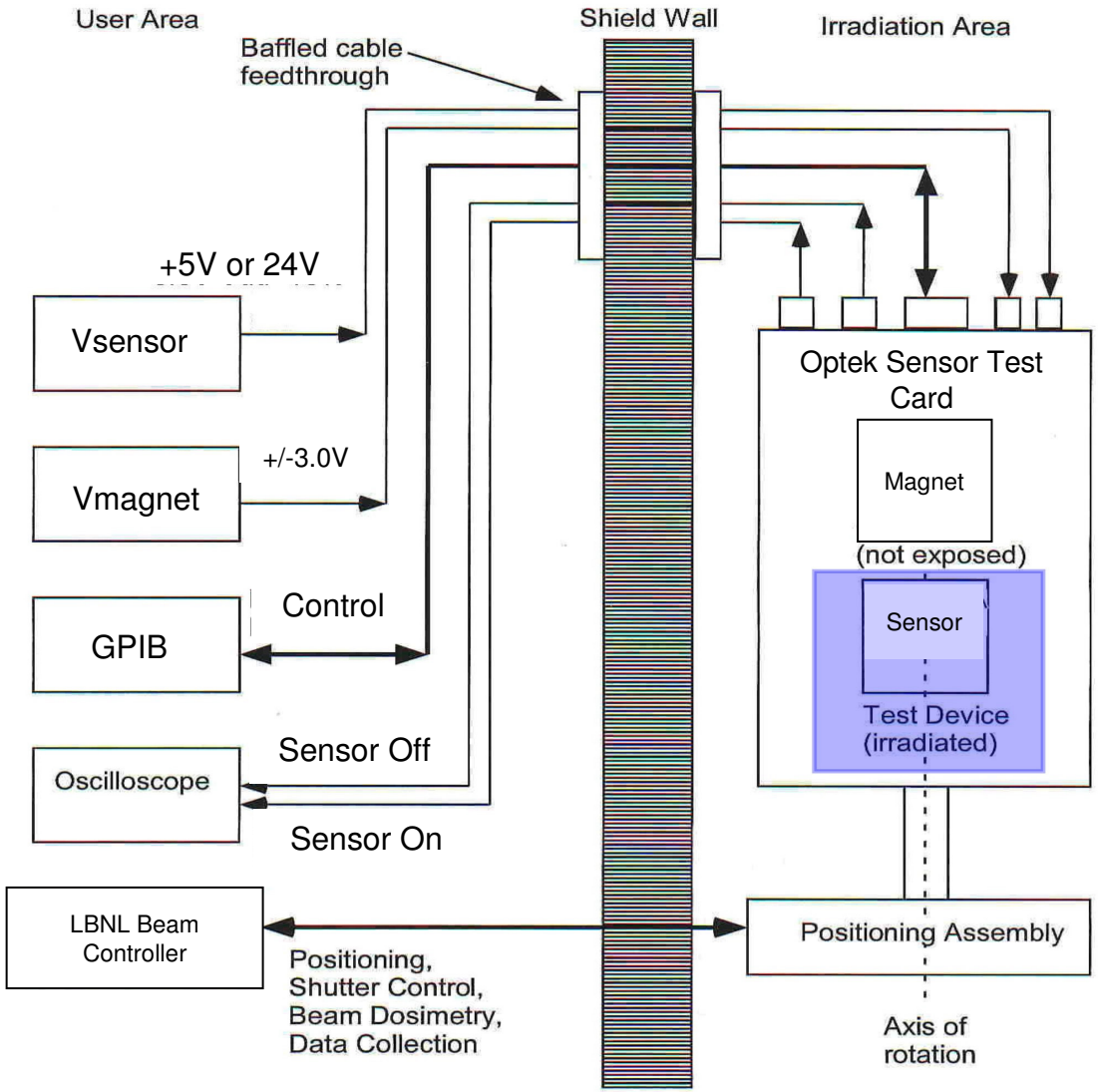
- **Determine the Single Event Latchup (SEL) and Single Event Transient (SET) susceptibility of the Optek Hall Effect Sensor, OMH3075, for transient interruptions in the output signal and for destructive events induced by exposing it to a heavy ion beam at the Lawrence Berkeley National Laboratory (LBNL). Utilizing the Berkeley Accelerator Space Effects Facility (BASEF), this test was performed for the potential use in electronic circuitry for the Sample Analysis at Mars (SAM) Instrument as a part of the Mars Science Laboratory (MSL) Project.**
- **The design engineers on the project had pre-selected this device to control the motors of the Sample Manipulation System (SMS) of the SAM Instrument. This device needed to meet the SEL requirement of >80 MeV-cm2/mg for the Mars Mission.**

Test Board

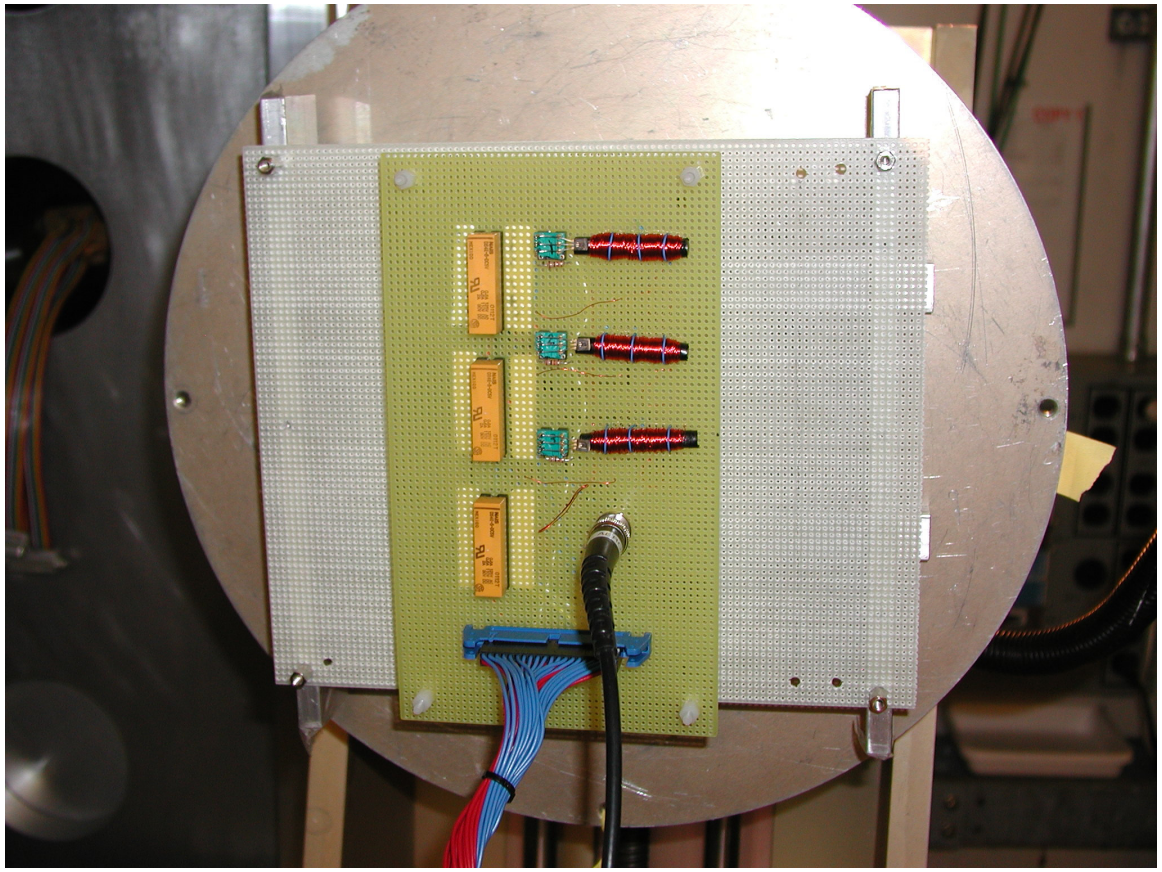


The Optek Hall Effect Sensor OMH3075 Test Board

Test Configuration



Test Board Alignment



The Optek Hall Effect Sensor OMH3075 mounted for beam at LBNL

Ion Beam Characteristics

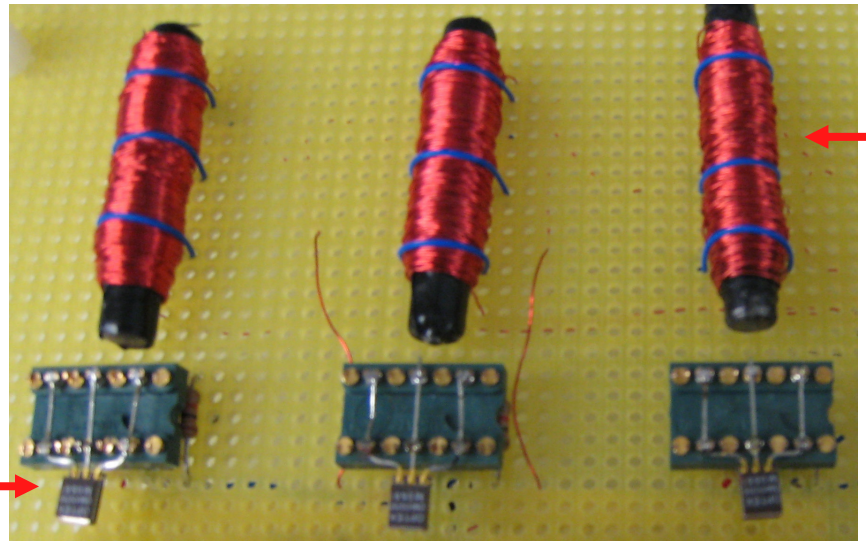
Ion	LET (MeV•cm2/mg)	Angle (degrees)
Xe	58.7	0
Xe	67.8	30
Xe	83.0	45

- **Facility:** **Lawrence Berkeley National Laboratory, 10MeV/amu tune**
- **Flux:** **1.47 x 10^3 to 1.26 x 10^5 particles/cm^2/s.**
- **Fluence:** **1 x 10^7 p/cm^2 or until destructive**

OMH3075 Heavy Ion Testing at Room Temperature at LBNL

Test Techniques

Vsensor	Sensor	Magnet	Vmagnet	
5V	On	Inserted	+3V	South Pole Present
5V	Off	Inserted	-3V	North Pole Present
5V	On	Removed	0V	No Magnet Present
5V	Off	Removed	0V	No Magnet Present



Test Methods of the Optek Hall Effect Sensor using a magnet

On and Inserted Mode

Vsensor	Sensor	Magnet	Vmagnet
5V	On	Inserted	+3V
5V	Off	Inserted	-3V
5V	On	Removed	0V
5V	Off	Removed	0V

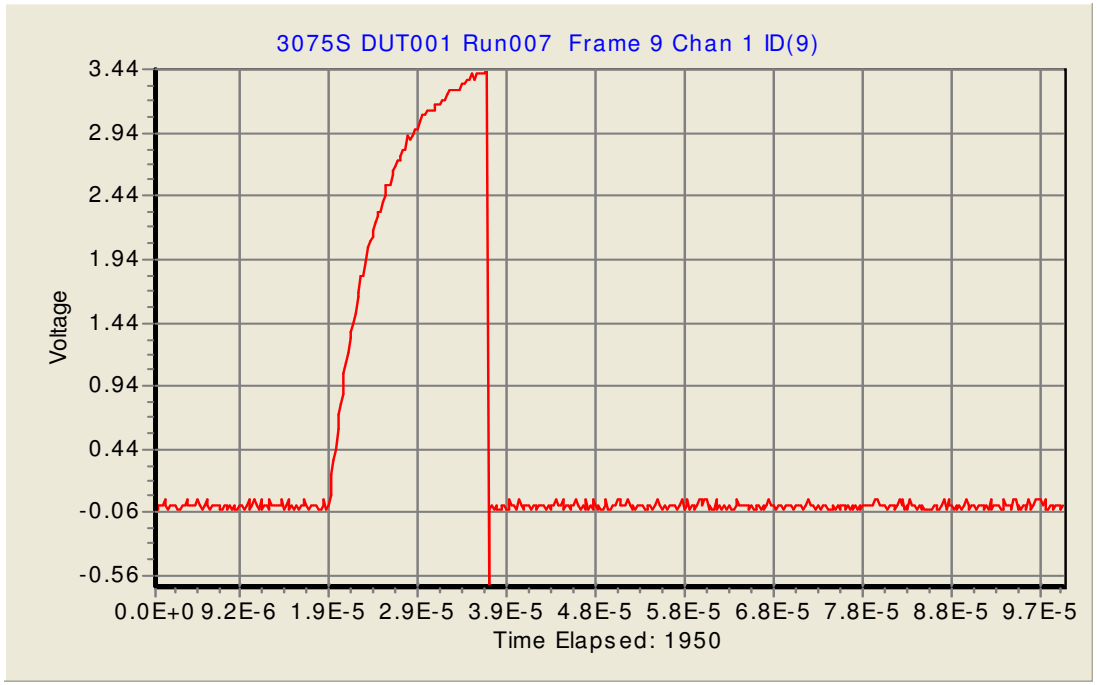
South Pole Present: logic level “0”

Sensor On and Magnet Inserted

Sensor Off →

FWHM Transient of 14us at 1.72V →

Sensor On →

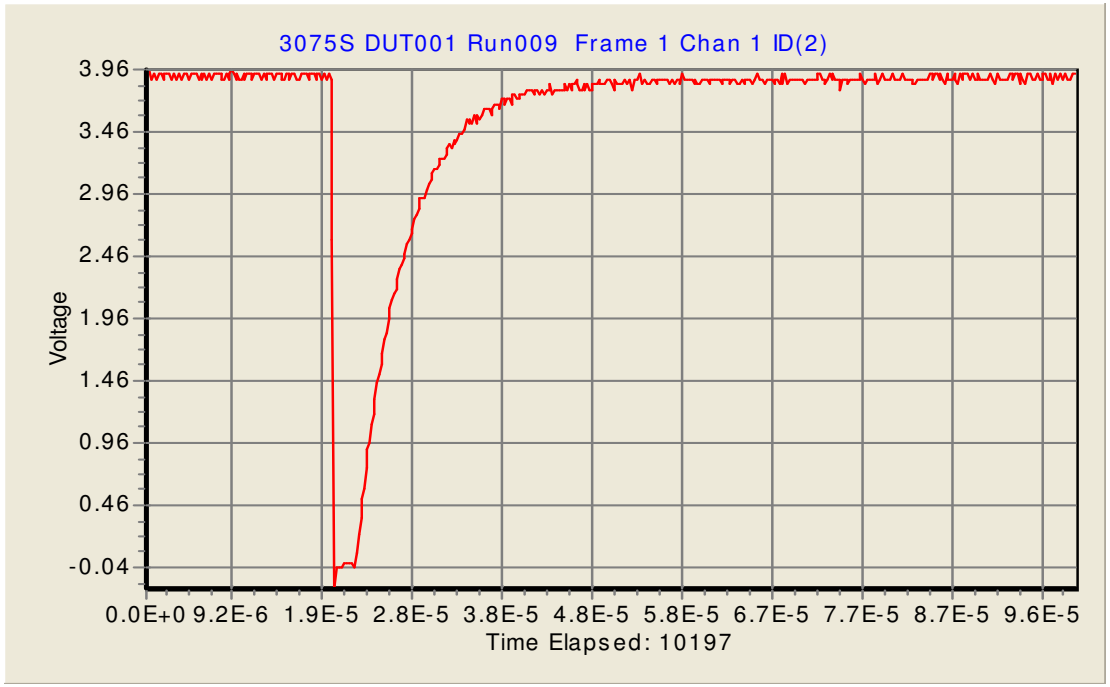


Off and Inserted Mode

North Pole Present: logic level “1”

Sensor Off and Magnet Inserted

Vsensor	Sensor	Magnet	Vmagnet
5V	On	Inserted	+3V
5V	Off	Inserted	-3V
5V	On	Removed	0V
5V	Off	Removed	0V



← Sensor Off

← FWHM Transient of 6us at 1.98V

← Sensor On

Magnet Removed Modes

Vsensor	Sensor	Magnet	Vmagnet
5V	On	Inserted	+3V
5V	Off	Inserted	-3V
5V	On	Removed	0V
5V	Off	Removed	0V

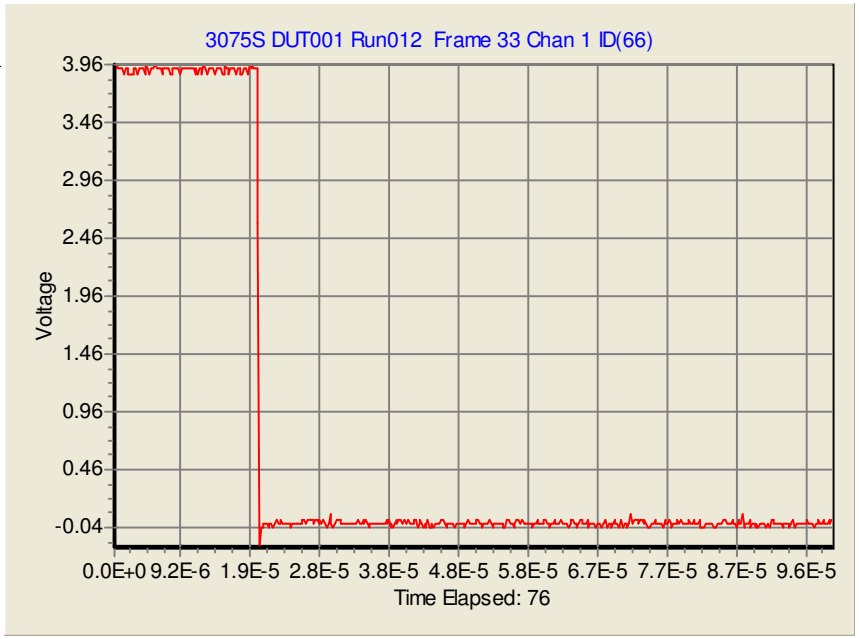
Transient of at least 80us for sensor on or off conditions

No Magnet Present

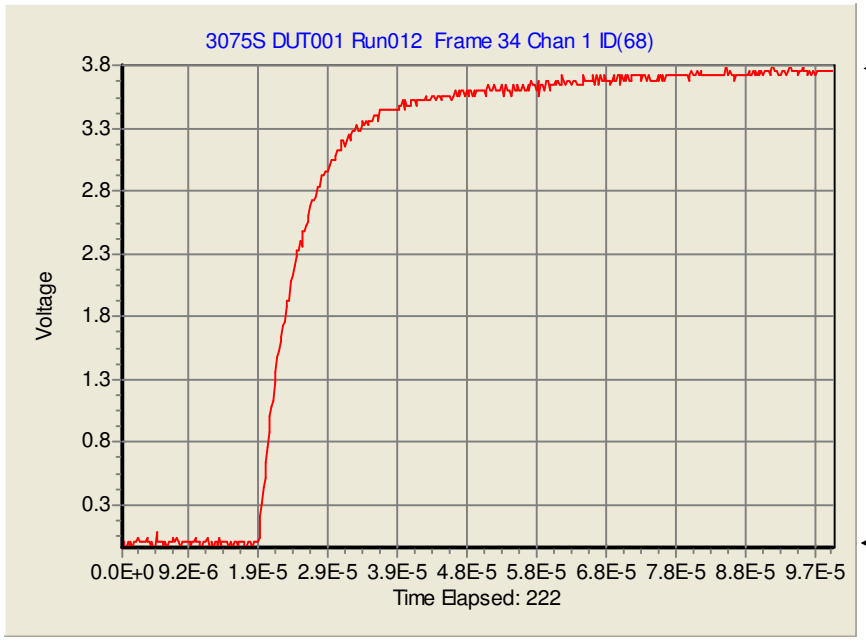
No Magnet Present

Off →

On →



Switch Off and Magnet Removed



← Off

← On

Switch On and Magnet Removed

Conclusion

- **On and inserted mode:**
  - **Full Width Half Max Transient of 14us**
  - **Magnetic pulls sensor back to on condition after transient event**
- **Off and inserted mode:**
  - **FWHM Transient of 6us**
  - **Magnetic pulls sensor back to off condition after transient event**
- **On/Off and removed mode:**
  - **Transient of at least 80us captured**
  - **Sensor remains in opposite condition after transient event**

Results Summary

- **Three Optek Hall Effect Sensor OMH3075 devices did not experience SEL up to an LET of 83 MeV/(mg/cm^2).**
- **The devices were exposed from a fluence of 9.74 x 10^3 to 1.00 x 10^7 particles/cm^2 of the Xenon ion beam per run.**
- **Transients were observed for all runs that can be handled through mitigation with magnet present.**
- **Magnetic presence is needed to return device to current condition after a transient event has occurred.**

Acknowledgements